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Rhizopus Soft Rot on Pear (*Pyrus serotina*) Caused by *Rhizopus stolonifer* in Korea

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Rhizopus soft rot caused by *Rhizopus stolonifer* occurred on pears (*Pyrus serotina*) in the Jinju City Agricultural Products Wholesale Market in Korea from 2004 to 2005. The infection usually started from wounds due to cracking at harvest time. The lesions started as water-soaked, rapidly softened, then gradually expanded. The mycelia grew vigorously on the surface of the fruits and formed stolons. Colonies on potato dextrose agar at 25°C were white cottony to brownish black. Sporangia were globose, black and 90~120 μm in size. Sporangiophores were light brown and 480~2600 × 12~18 μm in size. Sporangiospores were globose to oval, brownish, streaked, and 8~14 × 6~10 μm in size. Columella were light brownish gray, hemispherical and 70~80 μm in size. On the basis of these symptoms, mycological characteristics and pathogenicity tests on host plants, the fungus was identified as *Rhizopus stolonifer* (Ehrenb.) Vuill. This is the first report of rhizopus soft rot on pear (*P. serotina*) caused by *R. stolonifer* in Korea.

KEYWORDS: Pear, *Pyrus serotina*, Rhizopus soft rot, *Rhizopus stolonifer*

The soft rot on the succulent tissues of vegetable, fruits and ornamentals caused by *Rhizopus* sp. occurs throughout the world. The disease mainly occurs during sale, transports, marketshelf and storage. After harvest, *Rhizopus* is omnipresent as a saprophyte and sometimes as a weak parasite on stored organs of plants. When the epidermal cells are collapsed, the fungus emerges through the wounds and produces aerial sporangiophores, sporangia, stolons, and rhizoids, the latter capable of piercing the softened epidermis (Agrios, 2004).

In the autumns of 2004 and 2005, the disease suspected as rhizopus soft rot occurred on pears (*Pyrus serotina*) in the Jinju City Agricultural Products Wholesale Market. The infection rate of the disease in some container boxes reached up to 2.6%. *Rhizopus* attacked only the wounded mature pear fruits, but did not unwounded and immature ones. *R. stolonifer* is one of the most common members of the Mucorales and has a worldwide distribution, although it is most commonly occurring in warmer areas (Domsch, 1980).

Symptom. The infected parts of wounds on mature fruits appeared water-soaked at first, then became soft and rotten. White hyphae grew from the site where the fungus invaded primarily and covered the affected portions by producing tufted whiskerlike gray sporangiophores and sporangia (Fig. 1A). The infected tissues were finally broken down and disintegrated into watery rot. Longitudinal sections of the infected fruit appeared very soft and rapidly rotted (Fig. 1B).

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Mycological characteristics. The diseased pears (cv. Hosui) were collected from containers. The causal organism was isolated from mycelial tips on the diseased fruits. Brownish black fungal colonies were formed on potato dextrose agar in the dark at 25°C.

Sporangia and sporangiophores were carefully observed under a light microscope. The colonies grown on potato dextrose agar at 25°C were white cottony at first, and became heavily speckled with the appearance of sporangia and became browinish black, spreading rapidly by means of stolons fired at various points to the substrate by rhizoids (Fig. 2A). Mycological characteristics of the fungus causing soft rot of pear caused by *R. stolonifer* was indicated in Table 1. Sporangia were globose, white at first and then turned black with many spores, mostly 90~120 μm long (Fig. 2B). The sporangia contained thousands of spherical sporangiospores. Sporangiophores were pale to dark brown, usually straight, mostly 480~2600 × 12~18 μm wide, light brown, smooth-walled, simple, nonseptate, long, and arising in groups of 3~5 μm or more from stolons opposite rhizoids. Sporangiospores were globose, brownish, streaked, irregular, round, elongate, angular, and 8~14 ×6 ~8 μm in size (Fig. 2D). Most of the sporangiospores appeared to be readily dispersed in the air. Numerous sporangiospores were produced on the diseased fruits. Columella were subglobose to hemispheric, umberella in shape, light brownish gray in color, and mostly 70~80 μm in size (Fig. 2C). Zygospores were not measured. Rhizods and stolons were dark brown, hyaline abundantly branched rhizoids (Fig. 2E). The maximum temperature for mycelial growth was 30°C, minimum temperature 10°C and optimum temperature 25°C. Mycelial

Fig. 1. Symptoms of sot rot on pear fruits caused by the *Rhizopus* fungus isolated in this study. A: Typical symptom showing water-soaking and formed mycelia, sporangia and sporangiospores from a wounded fruit, B: Longitudinal section of an infected fruit, C: Symptom in an artificially inoculated fruit.

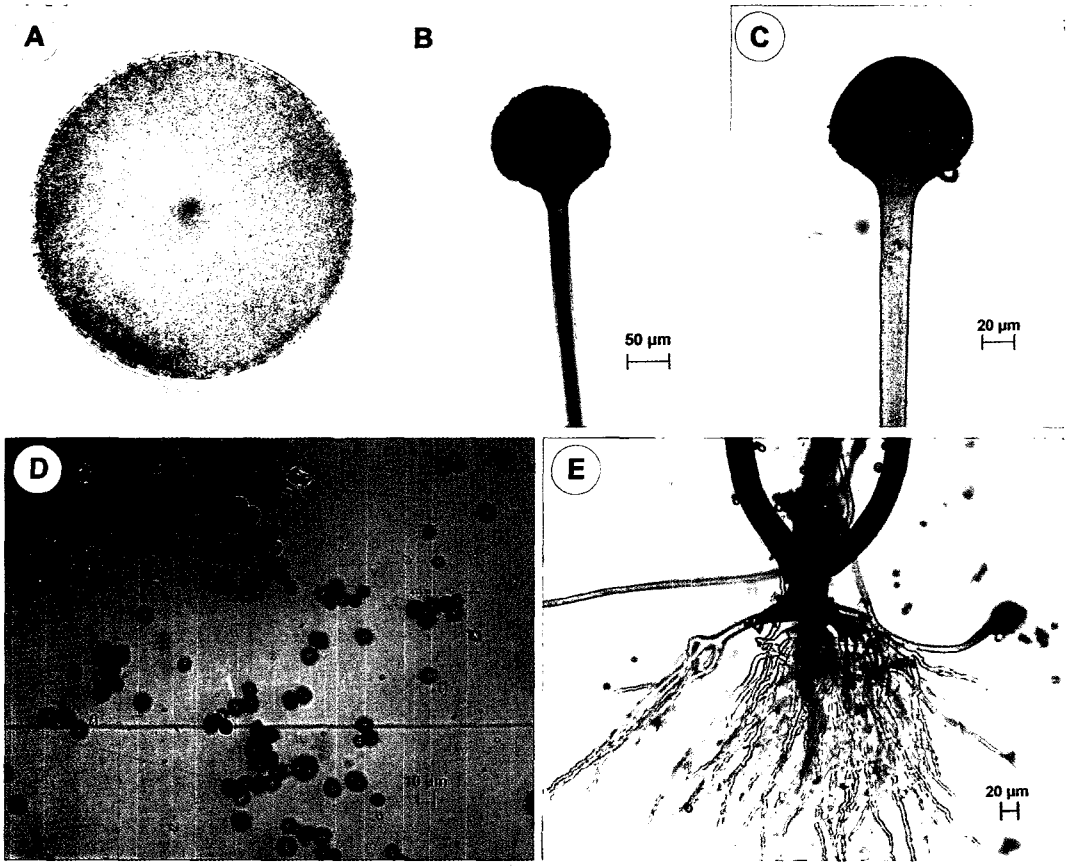

Fig. 2. Morphological characteristics of the *Rhizopus* fungus causing soft rot on pear. A: Mycelial growth on PDA after 48 hours incubation, B: Sporangium and sporangiophore. C: Columella, D: Sporangiospores, E: Rhizoids and stolons.

growth was measured 30 hours after innoculaton on PDA.

According to morphological characteristics, these results are almost identical to those of *Rhizopus stolonifer* (Ehrenberg ex. Fr.) Lind (Barnett and Hunter, 1986; Lunn, 1977; Gobayashi, *et al.*, 1992; Udagawa, *et al.*, 1980; Yasuda *et al.*, 1999).

Pathogenicity test. A conidial suspension of the *Rhizopus* (2×10^4/*ml*) was sprayed on wounded and unwounded pear fruits. Six fruits with single wound were each sprayed with 100 *ml* of the conidial suspension. The inoculated fruit was placed in a plastic ($29 \times 22 \times 15$ cm) humid chamber with 100% relative humidity at 25°C for 24 hours. Then the inoculated fruits were placed on a laboratory bench at room temperature. The typical symptoms on the pears (cv. Wonhwang) appeared 3 days after inoculation (Fig. 1C). The disease infection usually started at the wounded parts of the fruits. The symptoms were identical to those of naturally infected pears. Morphological characteristics of the fungi that were reisolated from artificially inoculated fruits were the same as those of naturally infected fruits, confirming Koch's postulate. The

Table 1. Comparison of morphological characteristics of the pathogenic *Rhizopus* isolated from soft rotten pear fruits

Characters		This study	*R. stolonifer*[a]
Colony	color	white cottony to brownish black	white cottony to brownish black
Sporangia	shape	globose	globose, subglobose
	size	90~120 μm	124 μm
Sporangiophores	color	light brown	brown
	size	480~2600 × 12~18 μm	600~3800 × 10~20 μm
Sporangiospores	shape	globose or oval	irregular round or oval
	size	8~14 × 6~10 μm	6~15(20) ×4 ~10(14) μm
Columella	shape	hemispherical	-
	size	70~80 μm	-
Zygospores	shape	not measured	black, subglobose
	size	not measured	100~200 μm

[a]Described by Yasuda *et al.* (1999).

rhizopus soft rot disease caused by *R. stolonifer* has not been reported on pear (*Pyrus serotina*) plants in Korea (The Korean Society of Plant Pathology. 2004). This is the first report of rhizopus soft rot on pear (*Pyrus serotina*) caused by *R. stolonifer* in Korea.

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